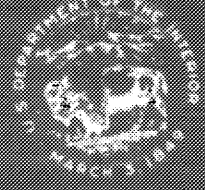
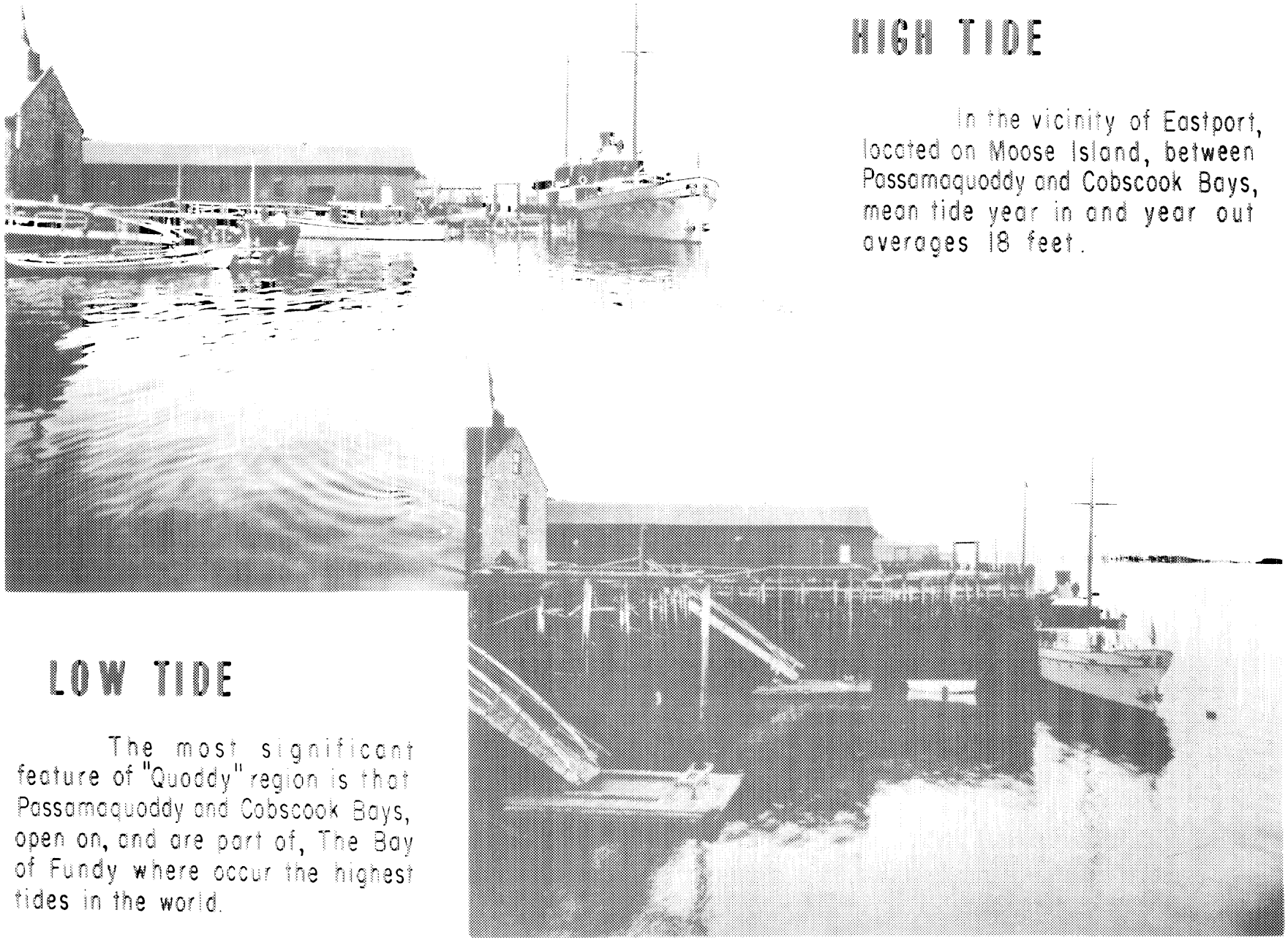
The International Passamaquoddy TIDAL POWER PROJECT and UPPER SAINT JOHN RIVER Hydroelectric Power Development



SUMMARY

REPORT to
President John F. Kennedy

Stewart L. Udall, Secretary
Department of the Interior
July 1963



HIGH TIDE

In the vicinity of Eastport, located on Moose Island, between Passamaquoddy and Cobscook Bays, mean tide year in and year out averages 18 feet.

LOW TIDE

The most significant feature of "Quoddy" region is that Passamaquoddy and Cobscook Bays, open on, and are part of, The Bay of Fundy where occur the highest tides in the world.

SUMMARY REPORT
of
The Passamaquoddy Study Committee of the Department of the Interior
on
The International Passamaquoddy Tidal Power Project
and
Upper St. John River Hydroelectric Power Development

The time is at hand for America to fulfill man's centuries-old dream of harnessing the energy of the tides.

The place is Passamaquoddy Bay on the U. S. -Canadian border between Maine and New Brunswick.

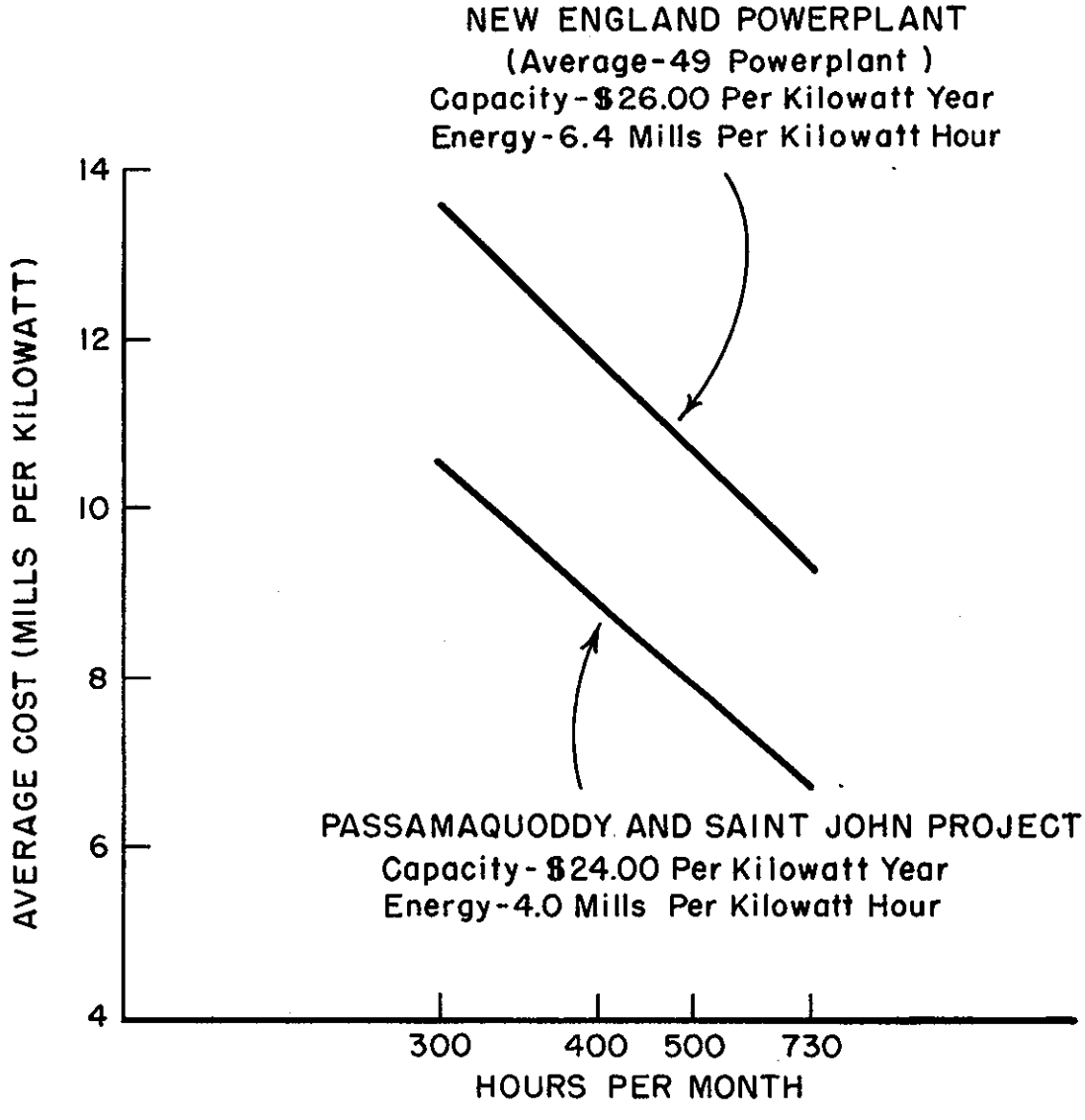
The primary result will be 1 million kilowatts of dependable and needed peaking capacity for the region and, combined with hydroelectric development of the Upper St. John River, 250,000 kilowatts of dependable load factor firm energy for use primarily in Maine, both at a cost substantially below the cost of alternative sources of power. The construction activity and resultant low-cost power will greatly benefit the economy of Maine, other New England states, and the Maritime Provinces of Canada. The International Passamaquoddy Tidal Project will be a unique engineering undertaking and will certainly become a tourist magnet, contributing further to the economy of the area.

By direction of the President, we have made an exhaustive review and study of the Report by the International Joint Commission on the International Passamaquoddy Tidal Power Project and the Upper St. John River. Our conclusion is that the Tidal Power Project is economically and engineeringly feasible alone or in conjunction with development of the Dickey site on the Upper St. John River for storage and power, and a reregulating dam at the Lincoln School site. The Dickey site would preserve for all time the recreational value and wilderness character of the Allagash River.

The Secretary of the Interior has recommended to the President that this report be used for the basis of early authorization of the Tidal Power Project and the storage and hydroelectric development of the Upper St. John River. The Secretary has recommended this as a U. S. project for construction by the U. S. Army Corps of Engineers and the marketing of the power by the Department of the Interior.

Because the Tidal Power Project would involve construction on both sides of the boundary, satisfactory arrangements will have to be worked out with Canada, including a sharing of the power and flood control benefits. The Secretary of the Interior has recommended to the President that the Secretary of State immediately initiate negotiations with the Government of Canada.

POWER COST AT PLANT
(No transmission)



Study Highlights

Our study was made in close collaboration with the Army Corps of Engineers and utilized load and resource data provided by the Federal Power Commission and the New Brunswick Electric Power Commission. It shows that:

-- The Tidal Power Project should be constructed to provide 1 million kilowatts of capacity.

-- It is economically feasible to operate this project primarily to provide1 million kilowatts of peaking power for only one hour per day, to meet the spiraling heavy 5-6 p.m. peak loads of the New England states and of the Maritime Provinces if they so desire.

-- A Storage and hydroelectric project at the Dickey site on the Upper St. John River, with a reregulating reservoir at the Lincoln School site, should be constructed and integrated with off-peak power from the Tidal Power Project to provide 250,000 kilowatts of dependable load factor energy.

-- Two 345,000-volt transmission circuits should be built from Passamaquoddy to Boston, with a switching point at Bangor, Maine, for interconnecting with three 230,000-volt circuits from the Dickey powerplant to Bangor.

-- Construction could be accomplished in three stages for the sake of orderly development. The first would be construction of

Dickey Dam and Reservoir with an initial installation of 150,000 kilowatts of capacity. The second, to be completed 5 years after completion of Stage 1, would be construction of Passamaquoddy Tidal Basin facilities and installation of 500,000 kilowatts of capacity, and an additional 300,000 kilowatts of capacity at Dickey. The third, to be accomplished 10 years after completion of Stage II facilities, would complete 1,000,000 kilowatts of installed capacity at Passamaquoddy and 750,000 kilowatts of installed capacity at Dickey. On this schedule because of the long construction period and lead time, both Passamaquoddy and Dickey would have to be started at about the same time.

-- Total cost of full development is estimated at $1,025,446,000, including $76,040,000 interest during construction.

-- At 2 7/8 per cent interest, the total cost can be repaid from power revenues in 50 years after each power unit goes on the line.

-- The benefit to cost ratio for Stage I is 2.55 to 1 and for full development, 1.27 to 1. Total annual costs for full development are $36,872,000 as against total project benefits of $46,849,000, of which $42,129,000 are power benefits, $2,065,000 recreation, and $2,655,000 area redevelopment.

-- Although we propose that the Tidal Power Project and Upper St. John River Development be fully integrated, our economic analysis clearly indicates that either project is financially feasible and could stand on its own feet as a separate project.

-- Full development will require 14,116 man-years of employment for local labor and provide $80,360,000 in wages and salaries.

-- Both peaking power and load factor firm power can be produced for $24 per kilowatt of capacity and 4 mills per kilowatt hour at site. This compares very favorably with the 1961 average of $26 and 6.36 mills for all power plants, hydro and thermal, in New England.

-- A ready market awaits this new source of supply. Existing thermal and hydro capacity in the New England states, Upper New York state, New Brunswick and Nova Scotia totalled 13.3 million kilowatts in 1960. The FPC and New Brunswick Electric Power Commission estimate that the area's power requirements in 1980 will be 36,000,000 kilowatts. To meet this load, 23,000,000 kilowatts of new capacity will be required.

-- Further, because of the flexibility of hydro operations for peaking purposes, Passamaquoddy-Dickey power will fit in ideally with the relatively inflexible large thermal generating units (possibly in excess of 500,000 kilowatts) which will be installed to meet future base load requirements in New England.

-- The Fish and Wildlife Service of this Department has reported that there will be no adverse effects on fish and wildlife from the Passamaquoddy Tidal Power Project.

-- As a matter of fact, the development of an alternate source of low-cost power creates an opportunity to enhance the fisheries of

New England by removal of existing small, inefficient hydro projects which now block the migration of anadromous fish.

-- While no dollar value was attributed to flood control and storage, the upper St. John will provide almost complete regulation of the river above Dickey and will provide flood control protection for the lower St. John River.

-- Storage on the upper St. John River will greatly increase the kilowatt output of downstream power dams on the St. John River on the Canadian side of the border.

The Tides as an Energy Source

In contemplating the potential of Passamaquoddy, it is important to recognize that the tide is a perpetual energy source, fully predictable and dependable, and never in danger of drying up.

The level of the sea alternately rises and falls under the force of astronomic conditions dependent on the relative positions of the sun, earth and moon. The height of the tide varies with these forces and the physical make-up of the coastline. The greatest rise and fall of the tides in the world occur in the head of the Bay of Fundy, on the Nova Scotia coast, where tides as high as 40 to 50 feet occur. Passamaquoddy Bay is a bay of about 110 square miles off the Bay of Fundy. Here tidal range varies from a maximum of 26 feet to a minimum of 12.7 feet, with an average tidal range of 18.1 feet. There are generally two

complete tidal cycles, that is, two high tides and two low tides each day. This is the case in the Passamaquoddy Bay area.

For centuries, man has envisioned putting the rise and fall of the tides to work for him. As early as the 11th century, man developed "tide mills" in Europe, and such installations were built in America as early as 1617. They were used mainly for grinding corn or spices--work that could be adjusted to the periodic flow of the tides.

To produce electric energy from water requires water falling from a higher elevation to a lower elevation, and passing through turbines which spin generators. To utilize the tides for production of electric power and to assure having power when it is needed require storage to hold back large quantities of water at high tide for release through turbines at low tide. The job can be done with a single large pool regulated by flood gates, but in such event power can be produced only at those times in the tidal cycle when the difference between the elevation of the pool and the ocean is sufficient for operation of turbines. A combination of two storage pools, however, one to store incoming tide waters at a high level and the other at low level with gates to keep the high tides out, can make possible some generation around the clock.

The Passamaquoddy Tidal Power Project is a two-pool plan, with Passamaquoddy Bay trapping the incoming tide waters and providing the high storage pool for water to be dropped through turbines into the low pool to be formed by the adjacent Cobscook Bay.

The only tidal development for electric power under full-scale construction today is the LaRance Tidal Project in France. The Russians are known to have plans for utilizing the tides to produce electric power also. Passamaquoddy represents the first and best chance for the United States to make a practical beginning in this new field of energy production.

History of Passamaquoddy

United States interest in developing the Passamaquoddy Tidal Power Project dates back to 1919 when Dexter P. Cooper, an eminent American engineer, backed by private investment capital first proposed a plan for harnessing the tides there.

In 1935 a Passamaquoddy Bay Tidal Project Commission of the United States' Federal Emergency Administration of Public Works recommended construction of an initial Cobscook Bay project with ultimate development planned to embrace Passamaquoddy Bay, and $7,000,000 was allotted to the Corps of Engineers to start construction. Work progressed until August 1936, but was discontinued due to lack of further appropriations by the Congress.

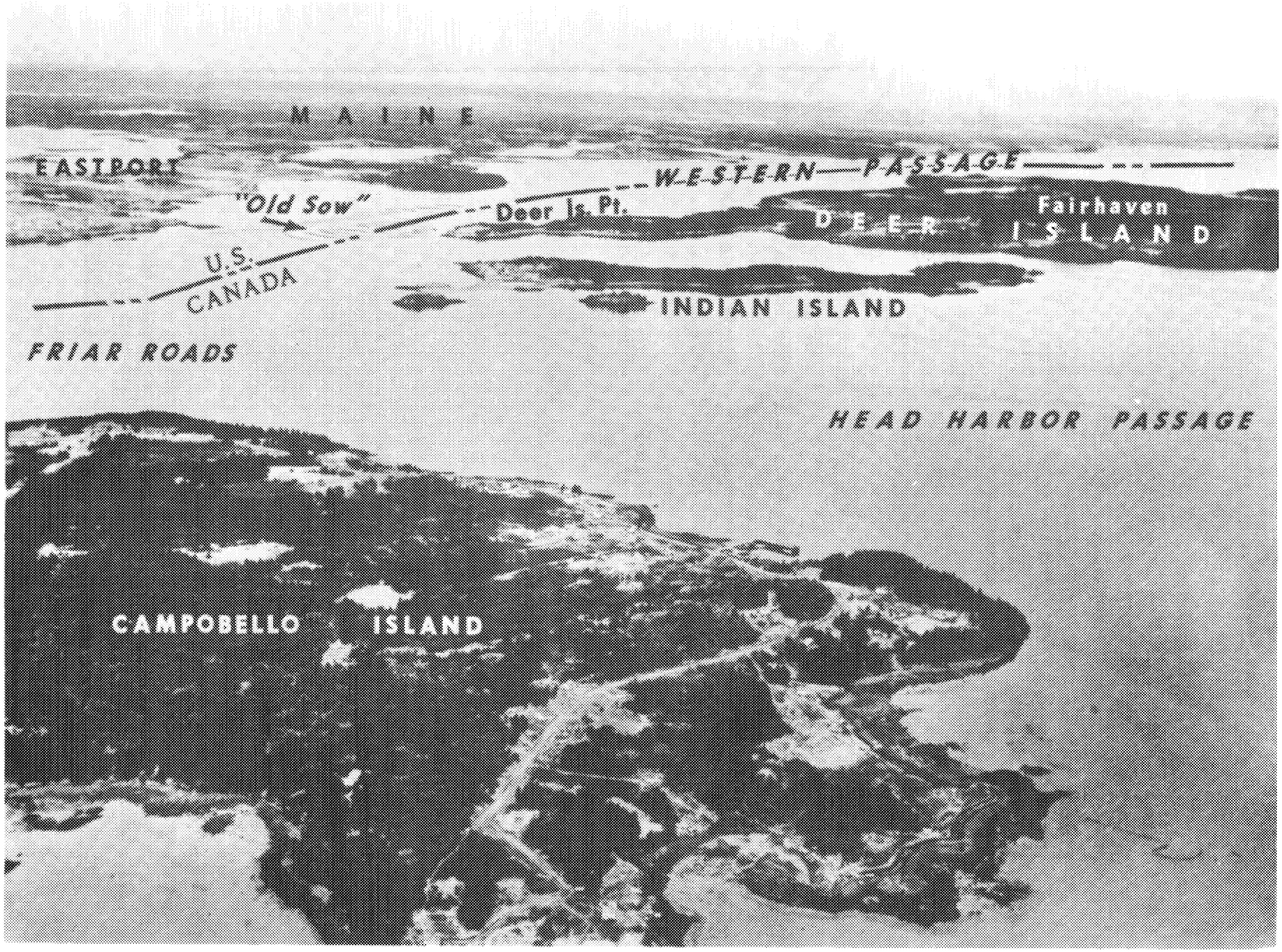
In 1941 the FPC reported that Passamaquoddy development could not compete successfully at that time with river hydroelectric power available in Maine.

In 1948 the Governments of the United States and Canada requested the International Joint Commission to review the then existing plans for

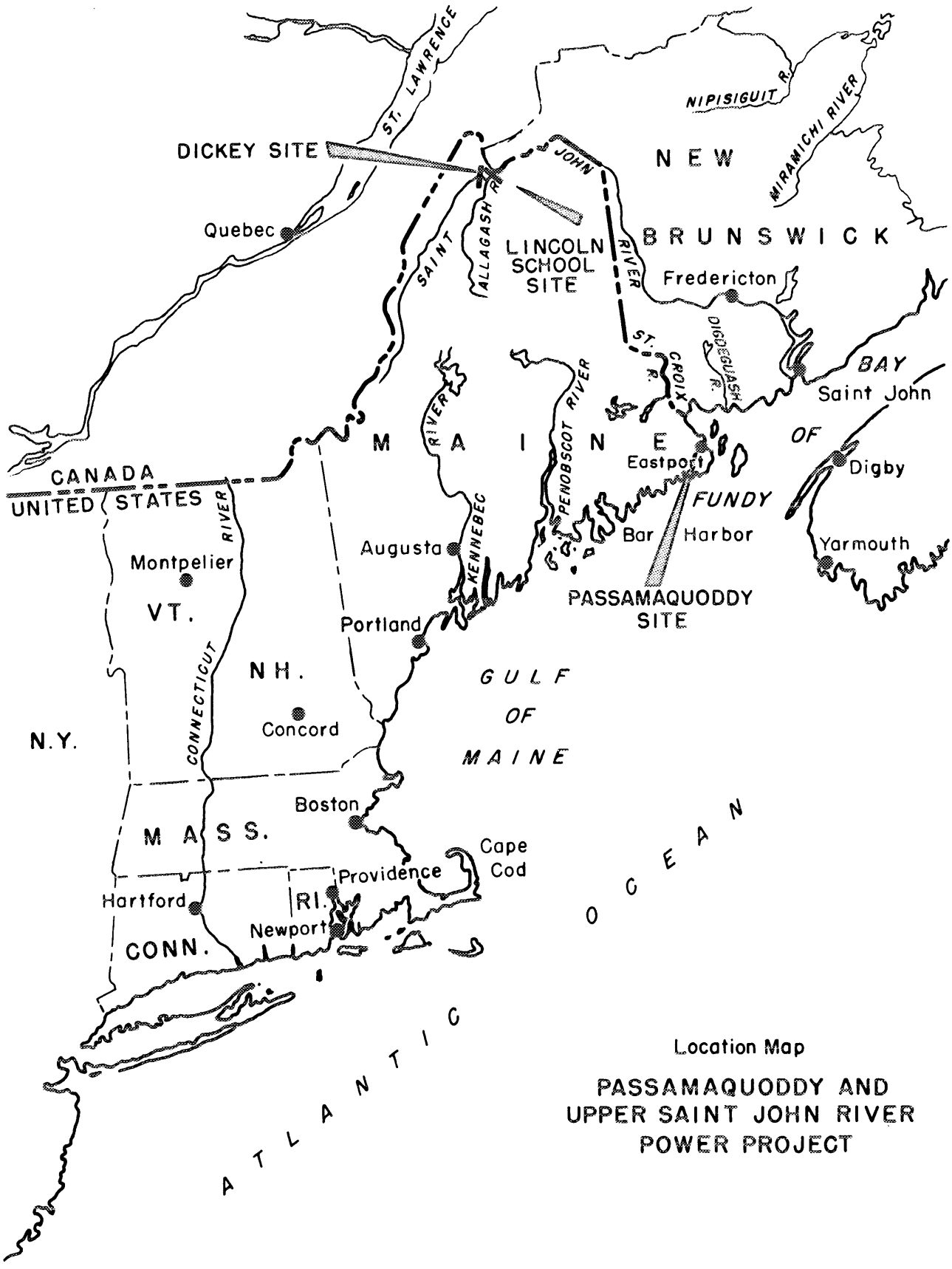
construction. In 1950 the IJC concluded that the economic feasibility of the Tidal Power Project could be determined only by careful and detailed investigations.

In 1956 the United States government put up $3,000,000 and the Canadian government $300,000 for the IJC to do the necessary detailed study.

In 1961 the IJC reported that the Tidal Power Project could be built but that it was not economically feasible under existing conditions. The IJC recommended that development of the project be viewed as a long-range possibility having better prospects of realization after other less costly energy resources had been developed. The IJC report pointed out, however, that economic feasibility of the project could be affected by future changes in costs and by giving value to certain public benefits such as recreation which were not considered in its economic evaluation. The IJC found the best of the plans studied to be a combination of the Passamaquoddy Tidal Power Project and development of incremental capacity at the proposed Rankin Rapids project on the Upper St. John River with 300,000 kilowatts of dependable capacity. Development of the Rankin Rapids project was opposed by sportsmen and conservationists on the grounds it would have flooded a series of unspoiled and scenic rapids in the lower reaches of the Allagash River. (The Dickey site, by contrast, is upstream from the mouth of the Allagash River.)



THE "QUODDY" REGION - *A Setting of Unsurpassed Beauty*



Location Map

PASSAMAQUODDY AND
UPPER SAINT JOHN RIVER
POWER PROJECT

A New Look

President Kennedy, by letter of May 20, 1961, requested the Secretary of the Interior to review and evaluate the IJC report, with special consideration as to what changes in fuel, engineering and financing cost might result in making the project economically feasible. Our Study Committee had a load and resources study made in the area which clearly indicated that the Tidal Power Project would be feasible if developed as a peaking powerplant with 1 million kilowatts capacity instead of the 300,000 kilowatts contemplated by the IJC. The loads and resources study also embraced a power marketing area considerably more extensive than that used by the IJC, taking into account technological advances in the power industry since its report. Additional studies were made and the results are given in our full report in terms of tangible power, recreation and area development benefits.

The plan developed in this review differs from the plan described as best in the IJC report in these major respects:

1. We propose increasing the Passamaquoddy Tidal Power Project capacity from 300,000 to 1 million kilowatts.

2. We propose that the project be operated for short periods every day for peaking power production to fit the anticipated load pattern of the area.

3. We propose use of axial flow type hydraulic turbines in lieu of conventional vertical shaft turbines.

4. We propose Upper St. John River storage and power development at the Dickey site instead of the Rankin Rapids site.

5. We propose some modification of the reregulating dam and power production facilities at the Lincoln School site.

Our plan for providing 1 million kilowatts capacity at Passamaquoddy contemplates construction of two 50-unit power plants of 500,000 kilowatt capacity each. One would be located at Carryingplace Cove and the other at Carlow Island.

The axial flow hydraulic turbine was considered in the IJC report but was not recommended at that time because it appeared that the cost differential compared to a conventional type hydraulic turbine did not justify its use. Additional technical, engineering and cost information now definitely support the use of axial flow hydraulic turbines.

Quoddy for Peaking

The electric utility load pattern for the New England-Maritime Provinces area has only one sharp peak each day. It occurs approximately between 5 and 6 p. m. and on load curves is so pronounced that it can be described more properly as a "spike" rather than a "peak."

The basic-operating plan for Passamaquoddy as a "peaking" power plant is this: During the high tide prior to a peaking period, the high pool is filled to the highest possible elevation. Similarly, during the low tide prior to a peaking period, the low pool is emptied to the lowest

possible elevation. These pool elevations are then maintained until the start of the peaking period when water from the high pool is dropped through the power plants to the lower pool. Water accumulated in the lower pool then is released to the ocean through emptying gates whenever the ocean tide is below the level in this pool.

Following the peaking period, off-peak or secondary energy then can be produced until the time and tides are such that the pools must be refilled or emptied in preparation for the next peaking period. We estimate that about 1 billion kilowatt-hours of off-peak energy could be generated by Passamaquoddy and, as a result of the Upper St. John development, about 600 million kilowatt-hours of energy at downstream hydroelectric plants of the New Brunswick Electric Power Commission.

By itself, the hydro project at the Dickey site could produce only about 150,000 kilowatts of dependable 60 per cent load factor power. Integrated with off-peak Passamaquoddy power, it can produce 250,000 kilowatts of dependable load factor power. Further, Dickey capacity can be used for peaking during neap tides when not enough water would flow into the high pool for Passamaquoddy to generate its entire 1 million kilowatts of capacity for a full hour.

The Dickey power plant would not, by itself, be able to use all of the off-peak power available from Passamaquoddy for integration into a firm energy pattern. This means off-peak Passamaquoddy power

would be available for integration with potential other hydro projects in the area.

Reregulation and Downstream Benefits

A hydro plant operating to serve a load with sharp peak characteristics requires a reservoir downstream to catch the water released through the turbines during peaking hours and reregulate the flow of the river. The reregulating reservoir for the Dickey site is proposed for the Lincoln School site. Further studies are required as to the precise location of the Dickey power plant site and the contemplated discharge from this plant. No cost estimates were included in the present study to cover the cost of the reregulating reservoir. However, we anticipate that power revenues from reregulating reservoir will support the cost thereof; therefore cost of this facility is not a factor in the over-all plan of development.

Considerable benefits would accrue to existing and potential downstream hydro developments by virtue of storage on the Upper St. John River. An estimate of these benefits was obtained from studies made of the St. John River by the St. John River Board of the New Brunswick Electric Power Commission. For the Dickey development, they range from 225 million kilowatt hours per year to 739 million kilowatt hours per year between 1970 and 1980, and in most of these years would be greater than 500 million kilowatt hours. After 1980 they level out at 650 million kilowatt hours.

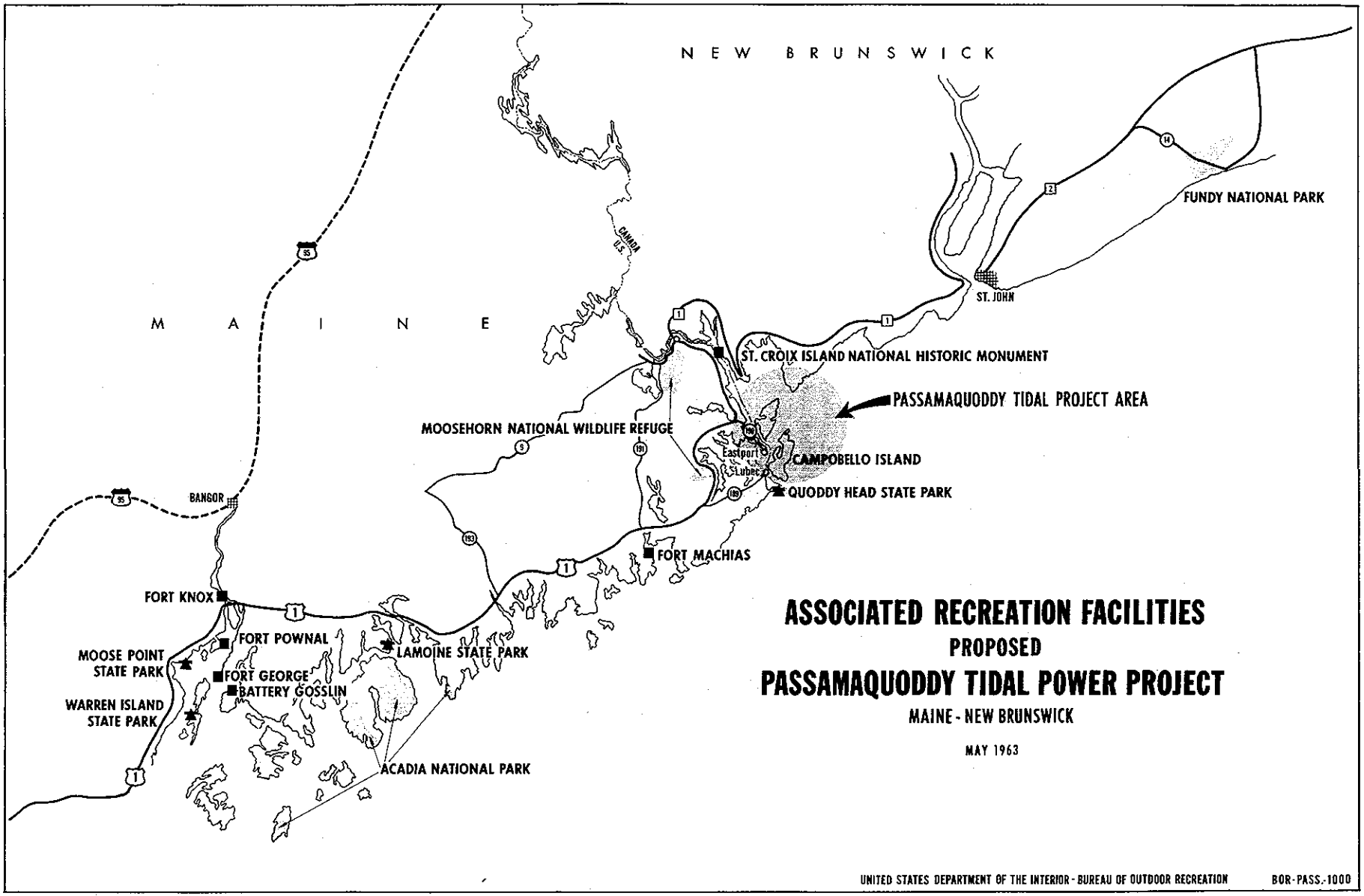
Recreation Benefits

Passamaquoddy and Cobscook Bays offer a panorama of water and scenic views complemented by the Fundy Isles of Campobello, Deer Island and Grand Manan, all located in Canada.

The principal attraction to tourists would be the tidal power project itself, featuring ocean dams 7 1/2 miles in total length. An engineering marvel, its operations would feature the rise and fall of the tides, the impounding of water in two natural pools, navigation locks for unrestricted movement of boats, emptying and filling gates, and power transmission.

Many hundreds of thousands of persons who now visit other parks and attractions in the general area doubtless would make a stopover at Passamaquoddy which will attract additional hundreds of thousands of visitors. This would greatly benefit the area, particularly Washington County, headquarters of the proposed project. This county now has the lowest median income of any county in Maine.

The Bureau of Outdoor Recreation estimates that present visitations to the Passamaquoddy area total about 216,000 visitor days and would be 500,000 visitor days by 1975, increasing to more than 4 1/2 million visitor days by the year 2025. We have applied the conservative recreational value of only 80 cents per visitor day in arriving at average annual recreational benefits of $2,065,000.


NEW BRUNSWICK
MAINE
CANADA
U.S.
FUNDY NATIONAL PARK
ST. JOHN
ST. CROIX ISLAND NATIONAL HISTORIC MONUMENT
PASSAMAQUODDY TIDAL PROJECT AREA
MOOSEHORN NATIONAL WILDLIFE REFUGE
Eastport
Lubec
CAMPOBELLO ISLAND
QUODDY HEAD STATE PARK
BANGOR
FORT MACHIAS
FORT KNOX
FORT POWNAL
LAMOINE STATE PARK
MOOSE POINT STATE PARK
FORT GEORGE
BATTERY GOSSLIN
WARREN ISLAND STATE PARK
ACADIA NATIONAL PARK
ASSOCIATED RECREATION FACILITIES
PROPOSED
PASSAMAQUODDY TIDAL POWER PROJECT
MAINE - NEW BRUNSWICK
MAY 1963
UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF OUTDOOR RECREATION
BOR-PASS.-1000

Because of the unique nature of the Passamaquoddy Tidal Project and its potential attraction for travellers, we have recommended that the project development include a visitor center with adequate parking facilities, picnic areas, boat launching sites at convenient locations, frequent roadside overlooks and interpretive signs at appropriate points.

Area Redevelopment Benefits

Both the Passamaquoddy and Dickey power developments are located within counties which are designated as "redevelopment areas" based on criteria set forth in the Area Redevelopment Act of 1961 (75 Stat. 47). Construction of these projects would significantly reduce unemployment in those two areas. An estimated 14,116 man-years of local labor would be utilized during construction of the full development, with annual wages and salaries amounting to an estimated $2,729,000 and total wages and salaries adding up to $80,360,000.

Summary

The Passamaquoddy Tidal Power Project and Upper St. John River Development are feasible and desirable from both an engineering and economic point of view. Their development will bring a significant block of low-cost power on the line at a time when it is needed. The Tidal Power Project with its 7 1/2 miles of dams would be a tourist magnet contributing further to the economy of the region.

France is already constructing a tidal power project and Russia is planning one. It will enhance the stature of the United States in the electric power field to proceed at once with the Passamaquoddy project. This project also will add to our store of electrical knowledge and possibly lead to economies of construction which will make feasible other tidal power projects in this country.

Harnessing the energy of the tides is a big idea and a big undertaking. We must think big and act big if we are to take full advantage of the opportunities modern technology holds out to us. Generally, the development of the Passamaquoddy Tidal Project and the Upper St. John River could do as much for New England and the Nation as Grand Coulee Dam has done for the Pacific Northwest and the Nation.

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON 25, D. C.

July 1, 1963

Dear Mr. President:

This is my reply to your letter of May 20, 1961, asking this Department to review the International Joint Commission's report on the International Passamaquoddy Tidal Project and the Upper Saint John River Hydroelectric Power Development.

You requested that I advise you concerning the changes in fuel, engineering and financial costs which might result in making the project economically feasible. After exhaustive review and study made in close collaboration with the U. S. Army Corps of Engineers, utilizing information on load and resource data furnished by the Federal Power Commission, and the technical know-how available from the bureaus within this Department, I am transmitting to you the report of our findings. I am also transmitting the report of the Secretary of the Army and the accompanying review by the Chief of Engineers commenting on the International Joint Commission report which have been fully coordinated with this Department.

I have determined that the development of the Passamaquoddy Tidal Project and the Upper Saint John River is both desirable and economically feasible. The plan envisions a tidal power development at Passamaquoddy Bay and a hydroelectric powerplant on the Upper Saint John River which would provide 1,250,000 kilowatts of dependable capacity, of which 1,000,000 kilowatts would be peaking capacity and 250,000 kilowatts of capacity which would meet the local area loads. You will be pleased to note that this proposed plan will preserve in its entirety the free-flowing nature of the Allagash River and its superb recreational values.

The Department's proposal is feasible from an engineering and economic viewpoint. The benefit-cost ratio is 1.27 to 1.00 based on current United States' project feasibility standards and using an interest rate of 2 7/8 percent with power repayment within 50 years after each unit becomes revenue-producing.

We recognize that suitable arrangements will have to be made with the Canadian Government for the United States to construct the Passamaquoddy Tidal Project and to work out an equitable sharing of the downstream benefits from power development of the Saint John River in Canada.

In view of the extensive previous studies made on this project dating back to 1922 and the opportunity which still exists for additional engineering work in advance of construction, I recommend that this report be used as the basis for early authorization of the International Passamaquoddy Tidal Power Project and the storage and hydroelectric development on the Upper Saint John River by the U. S. Army Corps of Engineers and the marketing of the power by the Department of the Interior.

I also recommend that you request the Secretary of State to immediately initiate negotiations with the Government of Canada, looking toward a satisfactory arrangement for the sharing of the power and flood control benefits of the Saint John River in Canada and the development of the Passamaquoddy Tidal Power Project by the United States.

Respectfully yours,

Secretary of the Interior

The President
The White House
Washington, D. C.

Enclosures

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON 25, D. C.

July 1, 1963

Memorandum

To: Secretary of the Interior

From: Passamaquoddy-Saint John River Study Committee

Subject: The International Passamaquoddy Tidal Power Project and the Upper Saint John River Hydroelectric Power Development

We herewith submit our final report on the International Passamaquoddy Tidal Power Project and Upper Saint John River Hydroelectric Power Development in accordance with your direction.

This report has been prepared under the general supervision of Assistant Secretary Kenneth Holum, Water and Power Development, and under the personal supervision of Under Secretary James K. Carr. This work has been done in response to the President's request of May 20, 1961, in which the Department of the Interior was asked to review the International Joint Commission report and to advise the President as to what changes in fuel, engineering and financing costs might result in making the project economically feasible. It was also requested that the President be advised as to the hydroelectric power development on the Upper Saint John River and other matters relating to the International Joint Commission report.

Morgan D. Dubrow
Morgan D. Dubrow, Chairman

Knoland J. Plucknett
Knoland J. Plucknett

Chas. W. Leavy
Charles W. Leavy

Mark Abelson
Mark Abelson

J. Karl Lee
J. Karl Lee

Joseph E. Guidry
Joseph E. Guidry, Project Engineer

Attachment

CREATED BY ACT OF CONGRESS in 1849, the Department of the Interior is responsible for a wide variety of programs concerned with the management, conservation, and wise development of America's natural resources. For this reason it often is described as the "Department of Natural Resources."

Through a score of bureaus and offices the Department has responsibility for the use and management of millions of acres of federally owned lands; administers mining and mineral leasing on a sizable area of additional lands; irrigates reclaimed lands in the West; manages giant hydro-electric power systems; administers grazing and forestry programs on federally owned range and commercial forest lands; protects fish and wildlife resources; provides for conservation and development of outdoor recreation opportunities on a nationwide scale; conserves hundreds of vital scenic, historic, and park areas; conducts geologic research and surveys; encourages mineral exploration and conducts mineral research; promotes mine safety; conducts saline water research; administers oil import programs; operates helium plants and the Alaska Railroad; is responsible for the welfare of many thousands of people in the territories of the United States and exercises trusteeship for the well-being of additional hundreds of thousands of Indians, Aleuts, and Eskimos, as well as being charged with resource management of millions of acres of Indian-owned lands.

In its assigned function as the Nation's principal natural resource agency, the Department of the Interior bears a special obligation to assure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America, now and in the future.